**Graphical user interface

Description automatically generated**

**Purpose**

The network built demonstrates the usage of routing protocol BGP for internal network distribution of externally learned routes. BGP is typically used as an external routing protocol, meaning that it is used to connects different sites, companies, or organizations. However, BGP also supports the distribution of routes throughout an internal network. The advantage of using BGP for internal distribution of routes is that it brings the control and customizability that BGP has that typical internal gateway protocols like OSPF or EIGRP don’t have. For this reason, IBGP is useful in a central organization when connecting multiple external organizations together.

**Background Information**

In this lab, IBGP’s configuration was explored to connect two external organizations through a central, connecting organization. The choice of using IBGP to redistribute the external routes instead of redistributing over OSPF or EIGRP is that it simplifies the handling of external BGP routes. IBGP natively works with EBGP, resulting in the preservation of any BGP routing control information when passing it through an internal network.

IBGP, like EBGP, is a layer four protocol, meaning that it has reliability and control of packet handling baked into it. This increases flexibility but means that BGP requires layer three routes to their neighbors to initiate their layer four neighbor relationship. For this, internal routing protocols must be run beneath IBGP to create these layer three connections required. As a result, IBGP and an internal routing protocol are running at the same time internal to the network. The responsibility of the internal routing protocol is to guarantee internal connectivity and IBGP focuses on passing along external routes to other internal routers as well as routing external routes through the internal network to another external network.

A difference between IBGP and EBGP is the configured autonomous system number (AS number). The AS number is like a BGP identification number that determines which organization the router belongs to. Each router can only have one active AS number at a time. In EBGP, neighboring routers are using different AS numbers to signal that they are from different, external organizations. In IBGP, multiple routers share the same AS number, signaling that they are in the same organization.

As a result of this difference, the routers will handle routes distributed through IBGP and EBGP with different levels of trust. It might be intuitive for a router to trust routes distributed by another router within their own organization, but BGP prefers routes learned from external sources rather than internal sources. This is because within an organization, the routers running IBGP can be separated by multiple intermediate devices, and implies an indirect, secondhand source. However, when communicating with an external source using EBGP, it works with an implied direct connection with the source, making it a more likely to be correct source. As a result, EBGP has an administrative distance, the value used for determining trust in a source, of 20 and IBGP has 200. OSPF has an administrative distance of 110 and EIGRP has an administrative distance of 90, which makes sense as these internal protocols calculate and produce routes whereas IBGP only passes along supposed routes they know.

Another difference between EBGP and IBGP is the difference in configuring neighbor connections. EBGP implies a direct connection and typically shares a single connection to an external router, resulting in neighbor connections being configured using the IP addresses of the actual link connection. Because IBGP implies an indirect connection within an organization, it is common practice to configure IBGP neighbors using the loopback interfaces of each router as there is likely no physical link between the two routers. An advantage of using the loopback interface for neighbor connections is that even if the links connecting the two routers fail, the IBGP neighbors can maintain a connection if there is a secondary route between the two routers. Using the IP address of the physical link does not provide this advantage because once the link goes down, accessibility to the router goes down. Loopback addresses don’t depend on a link, so it requires the whole router to go down before it is technically unreachable.

**Lab Summary**

Seven routers were connected in a straight line. The routers were separated into three separate sites, with the first two routers in the first site, the next three routers are in the second site, and the last two routers in the third site. The first site is configured to use OSPF for internal routing and external BGP to peer with the second site. The third site is also configured with OSPF for internal routing and external BGP to peer with the second site. The second site connects both sites together and peers with the first and third sites with external BGP. Internally, the second site uses both EIGRP and iBGP. EIGRP is used for internal connectivity and iBGP is used to pass and distribute external routes from the first and third sites across the whole network. All routers were configured to use both IPv4 and IPv6 and had a loopback address configured.

**Lab Commands**

**Router (config) #router bgp <AS Number>**

Enables BGP on the router and enters BGP configuration mode. The AS (autonomous system) number identifies the router’s BGP configuration group. When configuring external BGP, two connected routers should have different AS numbers to signal they are on different groups. Unlike EIGRP and OSPF, BGP only has one router protocol configuration mode for both IPv4 and IPv6.

**Router(config-router) # no bgp default ipv4-unicast**

Turns off the default BGP operating mode that only distributes across IPv4. In other words, this command enables BGP’s operation in IPv6. Required for dual-stack operation.

**Router(config-router) # address-family <Address Family >**

Enters BGP address-family configuration mode. The address family parameter includes ipv4 and ipv6. Each brings the router to its respective configuration mode for either BGP for IPv4 or BGP IPv6. Once there, IP specific commands can be accessed.

**Router(config-router) # neighbor <IP Address> remote-as <Neighbor AS Number>**

Configures a BGP neighbor. The IP Address parameter can either be an IPv4 address or an IPv6 address. The Neighbor AS Number parameter requires the AS number of the adjacent router. This statically configures BGP to create a neighbor connection. This command must be entered correctly on both participating routers in order to form a neighbor connection. This command must be entered twice, once for IPv4 and once for IPv6, for dual stack operation.

**Router(config-router) # neighbor <IP Address > update-source Loopback0**

Configures the router to recognize a BGP neighbor as distributing through a loopback address. This makes sure that when two BGP neighbors are distributing information that their loopback addresses are used instead of a physical interface. The IP Address parameter can be an IPv4 or IPv6 address.

**Router(config-router-af) # neighbor <IP Address> activate**

Activates the BGP neighbor connection. IP Address parameter is either an IPv4 or IPv6 address. Entered in either the IPv4 or IPv6 address family configuration mode to activate respective neighbor connections.

**Router(config-router-af) # network <IPv4 Address> mask <Subnet Mask>**

Activates an IPv4 network for BGP information distribution. Used in IPv4 address family configuration mode.

**Router(config-router-af) # network <IPv6 Address>**

Activates an IPv6 network for BGP information distribution. Used in IPv6 address family configuration mode.

**Router(config-router-af) # redistribute <protocol> <protocol number>**

Allows BGP to distribute information from a different protocol. Protocol parameter includes OSPF and EIGRP. Protocol number would be the process-id of OSPF or AS number of EIGRP. Entered in either the IPv4 or IPv6 address family configuration mode to allow the distribution for other protocols in the respective IP version.

**Router(config-router) # redistribute <protocol> <protocol number>**

Used in OSPF or EIGRP router configuration mode to allow them to distribute information from a different routing protocol. Protocol parameter includes BGP. Protocol number would be the AS number of the local BGP connection.

**Router# show ip protocols**

Shows all the configured IP protocols on the router.

**Router# show ipv6 protocols**

Shows all the configured IPv6 protocols on the router.

**Router# show bgp all summary**

Shows configured BGP neighbors and operation statistics on the router.

**Network Diagram with IP’s**

A picture containing diagram

Description automatically generated

**BGP 11**

**OSPF 0**

**BGP 10**

**OSPF 0**

**BGP 12**

**EIGRP 10**

|  |  |  |  |
| --- | --- | --- | --- |
| **Router Name** | Interface | IPv4 Address | IPv6 Address |
| **R3** | G0/0/0 | 192.168.0.29/30 | 2001:db8:acad:a::1/64 |
|  | G0/0/1 | N/A | N/A |
|  | Loopback0 | 192.168.0.1/30 | 2001:db8:acad:1::1/64 |
|  |  |  |  |
| **R4** | G0/0/0 | 192.168.0.30/30 | 2001:db8:acad:a::2/64 |
|  | G0/0/1 | 192.168.0.33/30 | 2001:db8:acad:b::1/64 |
|  | Loopback0 | 192.168.0.5/30 | 2001:db8:acad:2::1/64 |
|  |  |  |  |
| **R5** | G0/0/0 | 192.168.0.37/30 | 2001:db8:acad:c::1/64 |
|  | G0/0/1 | 192.168.0.34/30 | 2001:db8:acad:b::2/64 |
|  | Loopback0 | 192.168.0.9/30 | 2001:db8:acad:3::1/64 |
|  |  |  |  |
| **R6** | G0/0/0 | 192.168.0.38/30 | 2001:db8:acad:c::2/64 |
|  | G0/0/1 | 192.168.0.41/30 | 2001:db8:acad:d::1/64 |
|  | Loopback0 | 192.168.0.13/30 | 2001:db8:acad:4::1/64 |
|  |  |  |  |
| **R7** | G0/0/0 | 192.168.0.45/30 | 2001:db8:acad:e::1/64 |
|  | G0/0/1 | 192.168.0.42/30 | 2001:db8:acad:d::2/64 |
|  | Loopback0 | 192.168.0.17/30 | 2001:db8:acad:5::1/64 |
|  |  |  |  |
| **R8** | G0/0/0 | 192.168.0.46/30 | 2001:db8:acad:e::2/64 |
|  | G0/0/1 | 192.168.0.49/30 | 2001:db8:acad:f::1/64 |
|  | Loopback0 | 192.168.0.21/30 | 2001:db8:acad:6::1/64 |
|  |  |  |  |
| **R9** | G0/0/0 | N/A | N/A |
|  | G0/0/1 | 192.168.0.50 | 2001:db8:acad:f::2/64 |
|  | Loopback0 | 192.168.0.25/30 | 2001:db8:acad:7::1/64 |

**Configurations**

**Router 3**

**R3#show running-config**

Current configuration : 1733 bytes

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R3

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

ipv6 unicast-routing

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO214421BY

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface Loopback0

ip address 192.168.0.1 255.255.255.252

ip ospf 10 area 0

ipv6 address 2001:DB8:ACAD:1::1/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/0

ip address 192.168.0.29 255.255.255.252

ip ospf 10 area 0

negotiation auto

ipv6 address 2001:DB8:ACAD:A::1/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/1

no ip address

shutdown

negotiation auto

interface Serial0/1/0

no ip address

shutdown

interface Serial0/1/1

no ip address

shutdown

interface GigabitEthernet0/2/0

no ip address

shutdown

negotiation auto

interface GigabitEthernet0/2/1

no ip address

shutdown

negotiation auto

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

router ospf 10

redistribute bgp 10 subnets

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

ipv6 router ospf 10

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

**R3#show ip route**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2

i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2

ia - IS-IS inter area, \* - candidate default, U - per-user static route

o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

192.168.0.0/24 is variably subnetted, 15 subnets, 2 masks

C 192.168.0.0/30 is directly connected, Loopback0

L 192.168.0.1/32 is directly connected, Loopback0

O 192.168.0.5/32

[110/2] via 192.168.0.30, 00:22:24, GigabitEthernet0/0/0

O E2 192.168.0.8/30

[110/1] via 192.168.0.30, 00:22:24, GigabitEthernet0/0/0

O E2 192.168.0.12/30

[110/1] via 192.168.0.30, 00:21:27, GigabitEthernet0/0/0

O E2 192.168.0.16/30

[110/1] via 192.168.0.30, 00:21:27, GigabitEthernet0/0/0

O E2 192.168.0.20/30

[110/1] via 192.168.0.30, 00:21:27, GigabitEthernet0/0/0

O E2 192.168.0.25/32

[110/1] via 192.168.0.30, 00:21:27, GigabitEthernet0/0/0

C 192.168.0.28/30 is directly connected, GigabitEthernet0/0/0

L 192.168.0.29/32 is directly connected, GigabitEthernet0/0/0

O 192.168.0.32/30

[110/2] via 192.168.0.30, 00:22:24, GigabitEthernet0/0/0

O E2 192.168.0.36/30

[110/1] via 192.168.0.30, 00:21:57, GigabitEthernet0/0/0

O E2 192.168.0.40/30

[110/1] via 192.168.0.30, 00:21:27, GigabitEthernet0/0/0

O E2 192.168.0.44/30

[110/1] via 192.168.0.30, 00:21:27, GigabitEthernet0/0/0

O E2 192.168.0.48/30

[110/1] via 192.168.0.30, 00:21:27, GigabitEthernet0/0/0

**R3#show ipv6 route**

IPv6 Routing Table - default - 16 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application

C 2001:DB8:ACAD:1::/64 [0/0]

via Loopback0, directly connected

L 2001:DB8:ACAD:1::1/128 [0/0]

via Loopback0, receive

O 2001:DB8:ACAD:2::1/128 [110/1]

via FE80::521C:B0FF:FE42:AF80, GigabitEthernet0/0/0

OE2 2001:DB8:ACAD:3::/64 [110/1]

via FE80::521C:B0FF:FE42:AF80, GigabitEthernet0/0/0

OE2 2001:DB8:ACAD:4::/64 [110/1]

via FE80::521C:B0FF:FE42:AF80, GigabitEthernet0/0/0

OE2 2001:DB8:ACAD:5::/64 [110/1]

via FE80::521C:B0FF:FE42:AF80, GigabitEthernet0/0/0

OE2 2001:DB8:ACAD:6::/64 [110/1]

via FE80::521C:B0FF:FE42:AF80, GigabitEthernet0/0/0

OE2 2001:DB8:ACAD:7::1/128 [110/1]

via FE80::521C:B0FF:FE42:AF80, GigabitEthernet0/0/0

C 2001:DB8:ACAD:A::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD:A::1/128 [0/0]

via GigabitEthernet0/0/0, receive

O 2001:DB8:ACAD:B::/64 [110/2]

via FE80::521C:B0FF:FE42:AF80, GigabitEthernet0/0/0

OE2 2001:DB8:ACAD:C::/64 [110/1]

via FE80::521C:B0FF:FE42:AF80, GigabitEthernet0/0/0

OE2 2001:DB8:ACAD:D::/64 [110/1]

via FE80::521C:B0FF:FE42:AF80, GigabitEthernet0/0/0

OE2 2001:DB8:ACAD:E::/64 [110/1]

via FE80::521C:B0FF:FE42:AF80, GigabitEthernet0/0/0

OE2 2001:DB8:ACAD:F::/64 [110/1]

via FE80::521C:B0FF:FE42:AF80, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

**R3#show ip protocols**

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "ospf 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Router ID 192.168.0.1

It is an autonomous system boundary router

Redistributing External Routes from,

bgp 10, includes subnets in redistribution

Number of areas in this router is 1. 1 normal 0 stub 0 nssa

Maximum path: 4

Routing for Networks:

Routing on Interfaces Configured Explicitly (Area 0):

Loopback0

GigabitEthernet0/0/0

Routing Information Sources:

Gateway Distance Last Update

192.168.0.5 110 00:21:41

Distance: (default is 110)

**R3#show ipv6 protocols**

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "ospf 10"

Router ID 192.168.0.1

Number of areas: 1 normal, 0 stub, 0 nssa

Interfaces (Area 0):

Loopback0

GigabitEthernet0/0/0

Redistribution:

None

IPv6 Routing Protocol is "bgp 10"

**Router 4**

**R4#show running-config**

Current configuration : 2402 bytes

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R4

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

ipv6 unicast-routing

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO214913GF

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface Loopback0

ip address 192.168.0.5 255.255.255.252

ip ospf 10 area 0

ipv6 address 2001:DB8:ACAD:2::1/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/0

ip address 192.168.0.30 255.255.255.252

ip ospf 10 area 0

negotiation auto

ipv6 address 2001:DB8:ACAD:A::2/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/1

ip address 192.168.0.33 255.255.255.252

ip ospf 10 area 0

negotiation auto

ipv6 address 2001:DB8:ACAD:B::1/64

ipv6 ospf 10 area 0

interface Serial0/1/0

no ip address

shutdown

interface Serial0/1/1

no ip address

shutdown

interface GigabitEthernet0/2/0

no ip address

shutdown

negotiation auto

interface GigabitEthernet0/2/1

no ip address

shutdown

negotiation auto

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

router ospf 10

redistribute bgp 10 subnets

router bgp 10

bgp log-neighbor-changes

no bgp default ipv4-unicast

neighbor 2001:DB8:ACAD::2 remote-as 12

neighbor 2001:DB8:ACAD:B::2 remote-as 12

neighbor 192.168.0.34 remote-as 12

address-family ipv4

bgp redistribute-internal

network 192.168.0.32 mask 255.255.255.252

redistribute connected

redistribute ospf 10

neighbor 192.168.0.34 activate

exit-address-family

address-family ipv6

redistribute connected

redistribute ospf 10

neighbor 2001:DB8:ACAD::2 activate

neighbor 2001:DB8:ACAD:B::2 activate

exit-address-family

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

ipv6 router ospf 10

redistribute bgp 10

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

**R4#show ip route**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2

i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2

ia - IS-IS inter area, \* - candidate default, U - per-user static route

o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

192.168.0.0/24 is variably subnetted, 16 subnets, 2 masks

O 192.168.0.1/32

[110/2] via 192.168.0.29, 00:24:21, GigabitEthernet0/0/0

C 192.168.0.4/30 is directly connected, Loopback0

L 192.168.0.5/32 is directly connected, Loopback0

B 192.168.0.8/30 [20/0] via 192.168.0.34, 00:24:23

B 192.168.0.12/30 [20/130816] via 192.168.0.34, 00:23:23

B 192.168.0.16/30 [20/131072] via 192.168.0.34, 00:23:23

B 192.168.0.20/30 [20/0] via 192.168.0.34, 00:23:23

B 192.168.0.25/32 [20/0] via 192.168.0.34, 00:23:23

C 192.168.0.28/30 is directly connected, GigabitEthernet0/0/0

L 192.168.0.30/32 is directly connected, GigabitEthernet0/0/0

C 192.168.0.32/30 is directly connected, GigabitEthernet0/0/1

L 192.168.0.33/32 is directly connected, GigabitEthernet0/0/1

B 192.168.0.36/30 [20/0] via 192.168.0.34, 00:23:53

B 192.168.0.40/30 [20/3072] via 192.168.0.34, 00:23:23

B 192.168.0.44/30 [20/3328] via 192.168.0.34, 00:23:23

B 192.168.0.48/30 [20/0] via 192.168.0.34, 00:23:23

**R4#show ipv6 route**

IPv6 Routing Table - default - 17 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application

O 2001:DB8:ACAD:1::1/128 [110/1]

via FE80::B6A8:B9FF:FE01:B510, GigabitEthernet0/0/0

C 2001:DB8:ACAD:2::/64 [0/0]

via Loopback0, directly connected

L 2001:DB8:ACAD:2::1/128 [0/0]

via Loopback0, receive

B 2001:DB8:ACAD:3::/64 [20/0]

via FE80::521C:B0FF:FE2C:4C81, GigabitEthernet0/0/1

B 2001:DB8:ACAD:4::/64 [20/0]

via FE80::521C:B0FF:FE2C:4C81, GigabitEthernet0/0/1

B 2001:DB8:ACAD:5::/64 [20/0]

via FE80::521C:B0FF:FE2C:4C81, GigabitEthernet0/0/1

B 2001:DB8:ACAD:6::/64 [20/0]

via FE80::521C:B0FF:FE2C:4C81, GigabitEthernet0/0/1

B 2001:DB8:ACAD:7::1/128 [20/0]

via FE80::521C:B0FF:FE2C:4C81, GigabitEthernet0/0/1

C 2001:DB8:ACAD:A::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD:A::2/128 [0/0]

via GigabitEthernet0/0/0, receive

C 2001:DB8:ACAD:B::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:DB8:ACAD:B::1/128 [0/0]

via GigabitEthernet0/0/1, receive

B 2001:DB8:ACAD:C::/64 [20/0]

via FE80::521C:B0FF:FE2C:4C81, GigabitEthernet0/0/1

B 2001:DB8:ACAD:D::/64 [20/0]

via FE80::521C:B0FF:FE2C:4C81, GigabitEthernet0/0/1

B 2001:DB8:ACAD:E::/64 [20/0]

via FE80::521C:B0FF:FE2C:4C81, GigabitEthernet0/0/1

B 2001:DB8:ACAD:F::/64 [20/0]

via FE80::521C:B0FF:FE2C:4C81, GigabitEthernet0/0/1

L FF00::/8 [0/0]

via Null0, receive

**R4#show ip protocols**

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "ospf 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Router ID 192.168.0.5

It is an autonomous system boundary router

Redistributing External Routes from,

bgp 10, includes subnets in redistribution

Number of areas in this router is 1. 1 normal 0 stub 0 nssa

Maximum path: 4

Routing for Networks:

Routing on Interfaces Configured Explicitly (Area 0):

Loopback0

GigabitEthernet0/0/0

GigabitEthernet0/0/1

Routing Information Sources:

Gateway Distance Last Update

192.168.0.1 110 00:24:32

Distance: (default is 110)

Routing Protocol is "bgp 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

IGP synchronization is disabled

Automatic route summarization is disabled

Redistributing: connected, ospf 10 (internal)

Neighbor(s):

Address FiltIn FiltOut DistIn DistOut Weight RouteMap

192.168.0.34

Maximum path: 1

Routing Information Sources:

Gateway Distance Last Update

192.168.0.34 20 00:23:36

Distance: external 20 internal 200 local 200

**R4#show ipv6 protocols**

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "ospf 10"

Router ID 192.168.0.5

Autonomous system boundary router

Number of areas: 1 normal, 0 stub, 0 nssa

Interfaces (Area 0):

Loopback0

GigabitEthernet0/0/1

GigabitEthernet0/0/0

Redistribution:

Redistributing protocol bgp 10

IPv6 Routing Protocol is "bgp 10"

IGP synchronization is disabled

Redistribution:

Redistributing protocol connected

Redistributing protocol ospf 10 (internal)

Neighbor(s):

Address FiltIn FiltOut Weight RoutemapIn RoutemapOut

2001:DB8:ACAD::2

2001:DB8:ACAD:B::2

**R4#show bgp all summary**

For address family: IPv4 Unicast

BGP router identifier 192.168.0.5, local AS number 10

BGP table version is 14, main routing table version 14

13 network entries using 3224 bytes of memory

14 path entries using 1680 bytes of memory

10/9 BGP path/bestpath attribute entries using 2480 bytes of memory

2 BGP AS-PATH entries using 64 bytes of memory

0 BGP route-map cache entries using 0 bytes of memory

0 BGP filter-list cache entries using 0 bytes of memory

BGP using 7448 total bytes of memory

BGP activity 27/1 prefixes, 29/1 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd

192.168.0.34 4 12 38 33 14 0 0 00:24:56 10

For address family: IPv6 Unicast

BGP router identifier 192.168.0.5, local AS number 10

BGP table version is 29, main routing table version 29

13 network entries using 3536 bytes of memory

14 path entries using 2016 bytes of memory

5/5 BGP path/bestpath attribute entries using 1240 bytes of memory

2 BGP AS-PATH entries using 64 bytes of memory

0 BGP route-map cache entries using 0 bytes of memory

0 BGP filter-list cache entries using 0 bytes of memory

BGP using 6856 total bytes of memory

BGP activity 27/1 prefixes, 29/1 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd

2001:DB8:ACAD::2

4 12 0 0 1 0 0 never Idle

2001:DB8:ACAD:B::2

4 12 39 33 29 0 0 00:24:57 10

**Router 5**

**R5#show running-config**

Current configuration : 2719 bytes

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R5

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

ipv6 unicast-routing

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO21482HYV

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface Loopback0

ip address 192.168.0.9 255.255.255.252

ipv6 address 2001:DB8:ACAD:3::1/64

ipv6 eigrp 10

interface GigabitEthernet0/0/0

ip address 192.168.0.37 255.255.255.252

negotiation auto

ipv6 address 2001:DB8:ACAD:C::1/64

ipv6 eigrp 10

interface GigabitEthernet0/0/1

ip address 192.168.0.34 255.255.255.252

negotiation auto

ipv6 address 2001:DB8:ACAD:B::2/64

ipv6 eigrp 10

interface Serial0/1/0

interface Serial0/1/1

interface GigabitEthernet0/2/0

no ip address

shutdown

negotiation auto

interface GigabitEthernet0/2/1

no ip address

shutdown

negotiation auto

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

router eigrp 10

network 192.168.0.8 0.0.0.3

network 192.168.0.32 0.0.0.3

network 192.168.0.36 0.0.0.3

router bgp 12

bgp log-neighbor-changes

no bgp default ipv4-unicast

neighbor 2001:DB8:ACAD:4::1 remote-as 12

neighbor 2001:DB8:ACAD:4::1 update-source Loopback0

neighbor 2001:DB8:ACAD:5::1 remote-as 12

neighbor 2001:DB8:ACAD:5::1 update-source Loopback0

neighbor 2001:DB8:ACAD:B::1 remote-as 10

neighbor 192.168.0.13 remote-as 12

neighbor 192.168.0.13 update-source Loopback0

neighbor 192.168.0.17 remote-as 12

neighbor 192.168.0.17 update-source Loopback0

neighbor 192.168.0.33 remote-as 10

address-family ipv4

bgp redistribute-internal

network 192.168.0.32 mask 255.255.255.252

redistribute connected

redistribute eigrp 10

redistribute ospf 10

neighbor 192.168.0.13 activate

neighbor 192.168.0.17 activate

neighbor 192.168.0.33 activate

exit-address-family

address-family ipv6

neighbor 2001:DB8:ACAD:4::1 activate

neighbor 2001:DB8:ACAD:5::1 activate

neighbor 2001:DB8:ACAD:B::1 activate

exit-address-family

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

ipv6 router eigrp 10

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

**R5#show ip route**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2

i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2

ia - IS-IS inter area, \* - candidate default, U - per-user static route

o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

192.168.0.0/24 is variably subnetted, 16 subnets, 2 masks

B 192.168.0.1/32 [20/2] via 192.168.0.33, 00:26:05

B 192.168.0.4/30 [20/0] via 192.168.0.33, 00:26:35

C 192.168.0.8/30 is directly connected, Loopback0

L 192.168.0.9/32 is directly connected, Loopback0

D 192.168.0.12/30

[90/130816] via 192.168.0.38, 00:26:03, GigabitEthernet0/0/0

D 192.168.0.16/30

[90/131072] via 192.168.0.38, 00:26:02, GigabitEthernet0/0/0

B 192.168.0.20/30 [200/0] via 192.168.0.46, 00:25:53

B 192.168.0.25/32 [200/2] via 192.168.0.46, 00:25:53

B 192.168.0.28/30 [20/0] via 192.168.0.33, 00:26:35

C 192.168.0.32/30 is directly connected, GigabitEthernet0/0/1

L 192.168.0.34/32 is directly connected, GigabitEthernet0/0/1

C 192.168.0.36/30 is directly connected, GigabitEthernet0/0/0

L 192.168.0.37/32 is directly connected, GigabitEthernet0/0/0

D 192.168.0.40/30

[90/3072] via 192.168.0.38, 00:26:03, GigabitEthernet0/0/0

D 192.168.0.44/30

[90/3328] via 192.168.0.38, 00:26:02, GigabitEthernet0/0/0

B 192.168.0.48/30 [200/0] via 192.168.0.46, 00:25:53

**R5#show ipv6 route**

IPv6 Routing Table - default - 17 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application

B 2001:DB8:ACAD:1::1/128 [20/1]

via FE80::521C:B0FF:FE42:AF81, GigabitEthernet0/0/1

B 2001:DB8:ACAD:2::/64 [20/0]

via FE80::521C:B0FF:FE42:AF81, GigabitEthernet0/0/1

C 2001:DB8:ACAD:3::/64 [0/0]

via Loopback0, directly connected

L 2001:DB8:ACAD:3::1/128 [0/0]

via Loopback0, receive

D 2001:DB8:ACAD:4::/64 [90/130816]

via FE80::227:90FF:FEC7:8DB0, GigabitEthernet0/0/0

D 2001:DB8:ACAD:5::/64 [90/131072]

via FE80::227:90FF:FEC7:8DB0, GigabitEthernet0/0/0

B 2001:DB8:ACAD:6::/64 [200/0]

via 2001:DB8:ACAD:E::2

B 2001:DB8:ACAD:7::1/128 [200/1]

via 2001:DB8:ACAD:E::2

B 2001:DB8:ACAD:A::/64 [20/0]

via FE80::521C:B0FF:FE42:AF81, GigabitEthernet0/0/1

C 2001:DB8:ACAD:B::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:DB8:ACAD:B::2/128 [0/0]

via GigabitEthernet0/0/1, receive

C 2001:DB8:ACAD:C::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD:C::1/128 [0/0]

via GigabitEthernet0/0/0, receive

D 2001:DB8:ACAD:D::/64 [90/3072]

via FE80::227:90FF:FEC7:8DB0, GigabitEthernet0/0/0

D 2001:DB8:ACAD:E::/64 [90/3328]

via FE80::227:90FF:FEC7:8DB0, GigabitEthernet0/0/0

B 2001:DB8:ACAD:F::/64 [200/0]

via 2001:DB8:ACAD:E::2

L FF00::/8 [0/0]

via Null0, receive

**R5#show ip protocols**

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "eigrp 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Default networks flagged in outgoing updates

Default networks accepted from incoming updates

EIGRP-IPv4 Protocol for AS(10)

Metric weight K1=1, K2=0, K3=1, K4=0, K5=0

Soft SIA disabled

NSF-aware route hold timer is 240

EIGRP NSF disabled

NSF signal timer is 20s

NSF converge timer is 120s

Router-ID: 192.168.0.9

Topology : 0 (base)

Active Timer: 3 min

Distance: internal 90 external 170

Maximum path: 4

Maximum hopcount 100

Maximum metric variance 1

Automatic Summarization: disabled

Maximum path: 4

Routing for Networks:

192.168.0.8/30

192.168.0.32/30

192.168.0.36/30

Routing Information Sources:

Gateway Distance Last Update

192.168.0.38 90 00:26:16

Distance: internal 90 external 170

Routing Protocol is "bgp 12"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

IGP synchronization is disabled

Automatic route summarization is disabled

Redistributing: connected, eigrp 10, ospf 10 (internal)

Neighbor(s):

Address FiltIn FiltOut DistIn DistOut Weight RouteMap

192.168.0.13

192.168.0.17

192.168.0.33

Maximum path: 1

Routing Information Sources:

Gateway Distance Last Update

192.168.0.33 20 00:26:21

192.168.0.17 200 00:26:09

Distance: external 20 internal 200 local 200

**R5#show ipv6 protocols**

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "bgp 12"

IGP synchronization is disabled

Redistribution:

None

Neighbor(s):

Address FiltIn FiltOut Weight RoutemapIn RoutemapOut

2001:DB8:ACAD:4::1

2001:DB8:ACAD:5::1

2001:DB8:ACAD:B::1

IPv6 Routing Protocol is "eigrp 10"

EIGRP-IPv6 Protocol for AS(10)

Metric weight K1=1, K2=0, K3=1, K4=0, K5=0

Soft SIA disabled

NSF-aware route hold timer is 240

EIGRP NSF disabled

NSF signal timer is 20s

NSF converge timer is 120s

Router-ID: 192.168.0.9

Topology : 0 (base)

Active Timer: 3 min

Distance: internal 90 external 170

Maximum path: 16

Maximum hopcount 100

Maximum metric variance 1

Interfaces:

Loopback0

GigabitEthernet0/0/1

GigabitEthernet0/0/0

Redistribution:

None

**R5#show bgp all summary**

For address family: IPv4 Unicast

BGP router identifier 192.168.0.9, local AS number 12

BGP table version is 17, main routing table version 17

13 network entries using 3224 bytes of memory

21 path entries using 2520 bytes of memory

17/10 BGP path/bestpath attribute entries using 4216 bytes of memory

2 BGP AS-PATH entries using 48 bytes of memory

0 BGP route-map cache entries using 0 bytes of memory

0 BGP filter-list cache entries using 0 bytes of memory

BGP using 10008 total bytes of memory

BGP activity 27/1 prefixes, 36/1 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd

192.168.0.13 4 12 32 41 17 0 0 00:26:30 0

192.168.0.17 4 12 41 43 17 0 0 00:26:25 10

192.168.0.33 4 10 36 40 17 0 0 00:27:02 4

For address family: IPv6 Unicast

BGP router identifier 192.168.0.9, local AS number 12

BGP table version is 30, main routing table version 30

13 network entries using 3536 bytes of memory

14 path entries using 2016 bytes of memory

10/10 BGP path/bestpath attribute entries using 2480 bytes of memory

2 BGP AS-PATH entries using 48 bytes of memory

0 BGP route-map cache entries using 0 bytes of memory

0 BGP filter-list cache entries using 0 bytes of memory

BGP using 8080 total bytes of memory

BGP activity 27/1 prefixes, 36/1 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd

2001:DB8:ACAD:4::1

4 12 34 38 30 0 0 00:26:22 0

2001:DB8:ACAD:5::1

4 12 50 35 30 0 0 00:26:24 10

2001:DB8:ACAD:B::1

4 10 35 41 30 0 0 00:27:03 4

**Router 6**

**R6#show running-config**

Current configuration : 2327 bytes

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R6

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

ipv6 unicast-routing

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO214333H6

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface Loopback0

ip address 192.168.0.13 255.255.255.252

ipv6 address 2001:DB8:ACAD:4::1/64

ipv6 eigrp 10

interface GigabitEthernet0/0/0

ip address 192.168.0.38 255.255.255.252

negotiation auto

ipv6 address 2001:DB8:ACAD:C::2/64

ipv6 eigrp 10

interface GigabitEthernet0/0/1

ip address 192.168.0.41 255.255.255.252

negotiation auto

ipv6 address 2001:DB8:ACAD:D::1/64

ipv6 eigrp 10

interface Serial0/1/0

interface Serial0/1/1

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

router eigrp 10

network 192.168.0.12 0.0.0.3

network 192.168.0.36 0.0.0.3

network 192.168.0.40 0.0.0.3

router bgp 12

bgp log-neighbor-changes

neighbor 2001:DB8:ACAD:3::1 remote-as 12

neighbor 2001:DB8:ACAD:3::1 update-source Loopback0

neighbor 2001:DB8:ACAD:5::1 remote-as 12

neighbor 2001:DB8:ACAD:5::1 update-source Loopback0

neighbor 192.168.0.9 remote-as 12

neighbor 192.168.0.9 update-source Loopback0

neighbor 192.168.0.17 remote-as 12

neighbor 192.168.0.17 update-source Loopback0

address-family ipv4

no neighbor 2001:DB8:ACAD:3::1 activate

no neighbor 2001:DB8:ACAD:5::1 activate

neighbor 192.168.0.9 activate

neighbor 192.168.0.17 activate

exit-address-family

address-family ipv6

neighbor 2001:DB8:ACAD:3::1 activate

neighbor 2001:DB8:ACAD:5::1 activate

exit-address-family

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

ipv6 router eigrp 10

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

**R6#show ip route**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2

i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2

ia - IS-IS inter area, \* - candidate default, U - per-user static route

o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

192.168.0.0/24 is variably subnetted, 16 subnets, 2 masks

B 192.168.0.1/32 [200/2] via 192.168.0.33, 00:28:44

B 192.168.0.4/30 [200/0] via 192.168.0.33, 00:28:44

D 192.168.0.8/30

[90/130816] via 192.168.0.37, 00:28:53, GigabitEthernet0/0/0

C 192.168.0.12/30 is directly connected, Loopback0

L 192.168.0.13/32 is directly connected, Loopback0

D 192.168.0.16/30

[90/130816] via 192.168.0.42, 00:28:48, GigabitEthernet0/0/1

B 192.168.0.20/30 [200/0] via 192.168.0.46, 00:28:44

B 192.168.0.25/32 [200/2] via 192.168.0.46, 00:28:44

B 192.168.0.28/30 [200/0] via 192.168.0.33, 00:28:44

D 192.168.0.32/30

[90/3072] via 192.168.0.37, 00:28:53, GigabitEthernet0/0/0

C 192.168.0.36/30 is directly connected, GigabitEthernet0/0/0

L 192.168.0.38/32 is directly connected, GigabitEthernet0/0/0

C 192.168.0.40/30 is directly connected, GigabitEthernet0/0/1

L 192.168.0.41/32 is directly connected, GigabitEthernet0/0/1

D 192.168.0.44/30

[90/3072] via 192.168.0.42, 00:28:48, GigabitEthernet0/0/1

B 192.168.0.48/30 [200/0] via 192.168.0.46, 00:28:44

**R6#show ipv6 route**

IPv6 Routing Table - default - 17 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application

B 2001:DB8:ACAD:1::1/128 [200/1]

via 2001:DB8:ACAD:B::1

B 2001:DB8:ACAD:2::/64 [200/0]

via 2001:DB8:ACAD:B::1

D 2001:DB8:ACAD:3::/64 [90/130816]

via FE80::521C:B0FF:FE2C:4C80, GigabitEthernet0/0/0

C 2001:DB8:ACAD:4::/64 [0/0]

via Loopback0, directly connected

L 2001:DB8:ACAD:4::1/128 [0/0]

via Loopback0, receive

D 2001:DB8:ACAD:5::/64 [90/130816]

via FE80::B6A8:B9FF:FE01:AE51, GigabitEthernet0/0/1

B 2001:DB8:ACAD:6::/64 [200/0]

via 2001:DB8:ACAD:E::2

B 2001:DB8:ACAD:7::1/128 [200/1]

via 2001:DB8:ACAD:E::2

B 2001:DB8:ACAD:A::/64 [200/0]

via 2001:DB8:ACAD:B::1

D 2001:DB8:ACAD:B::/64 [90/3072]

via FE80::521C:B0FF:FE2C:4C80, GigabitEthernet0/0/0

C 2001:DB8:ACAD:C::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD:C::2/128 [0/0]

via GigabitEthernet0/0/0, receive

C 2001:DB8:ACAD:D::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:DB8:ACAD:D::1/128 [0/0]

via GigabitEthernet0/0/1, receive

D 2001:DB8:ACAD:E::/64 [90/3072]

via FE80::B6A8:B9FF:FE01:AE51, GigabitEthernet0/0/1

B 2001:DB8:ACAD:F::/64 [200/0]

via 2001:DB8:ACAD:E::2

L FF00::/8 [0/0]

via Null0, receive

**R6#show ip protocols**

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "eigrp 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Default networks flagged in outgoing updates

Default networks accepted from incoming updates

EIGRP-IPv4 Protocol for AS(10)

Metric weight K1=1, K2=0, K3=1, K4=0, K5=0

Soft SIA disabled

NSF-aware route hold timer is 240

EIGRP NSF disabled

NSF signal timer is 20s

NSF converge timer is 120s

Router-ID: 192.168.0.13

Topology : 0 (base)

Active Timer: 3 min

Distance: internal 90 external 170

Maximum path: 4

Maximum hopcount 100

Maximum metric variance 1

Automatic Summarization: disabled

Maximum path: 4

Routing for Networks:

192.168.0.12/30

192.168.0.36/30

192.168.0.40/30

Routing Information Sources:

Gateway Distance Last Update

192.168.0.42 90 00:29:03

192.168.0.37 90 00:29:03

Distance: internal 90 external 170

Routing Protocol is "bgp 12"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

IGP synchronization is disabled

Automatic route summarization is disabled

Neighbor(s):

Address FiltIn FiltOut DistIn DistOut Weight RouteMap

192.168.0.9

192.168.0.17

Maximum path: 1

Routing Information Sources:

Gateway Distance Last Update

192.168.0.9 200 00:29:02

192.168.0.17 200 00:29:02

Distance: external 20 internal 200 local 200

**R6#show ipv6 protocols**

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "bgp 12"

IGP synchronization is disabled

Redistribution:

None

Neighbor(s):

Address FiltIn FiltOut Weight RoutemapIn RoutemapOut

2001:DB8:ACAD:3::1

2001:DB8:ACAD:5::1

IPv6 Routing Protocol is "eigrp 10"

EIGRP-IPv6 Protocol for AS(10)

Metric weight K1=1, K2=0, K3=1, K4=0, K5=0

Soft SIA disabled

NSF-aware route hold timer is 240

EIGRP NSF disabled

NSF signal timer is 20s

NSF converge timer is 120s

Router-ID: 192.168.0.13

Topology : 0 (base)

Active Timer: 3 min

Distance: internal 90 external 170

Maximum path: 16

Maximum hopcount 100

Maximum metric variance 1

Interfaces:

Loopback0

GigabitEthernet0/0/0

GigabitEthernet0/0/1

Redistribution:

None

**Router 7**

**R7#show running-config**

Current configuration : 2563 bytes

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R7

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

ipv6 unicast-routing

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO214420HY

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface Loopback0

ip address 192.168.0.17 255.255.255.252

ipv6 address 2001:DB8:ACAD:5::1/64

ipv6 eigrp 10

interface GigabitEthernet0/0/0

ip address 192.168.0.45 255.255.255.252

negotiation auto

ipv6 address 2001:DB8:ACAD:E::1/64

ipv6 eigrp 10

interface GigabitEthernet0/0/1

ip address 192.168.0.42 255.255.255.252

negotiation auto

ipv6 address 2001:DB8:ACAD:D::2/64

ipv6 eigrp 10

interface Serial0/1/0

no ip address

interface Serial0/1/1

no ip address

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

negotiation auto

interface Vlan1

no ip address

router eigrp 10

network 192.168.0.16 0.0.0.3

network 192.168.0.40 0.0.0.3

network 192.168.0.44 0.0.0.3

router bgp 12

bgp log-neighbor-changes

no bgp default ipv4-unicast

neighbor 2001:DB8:ACAD:3::1 remote-as 12

neighbor 2001:DB8:ACAD:3::1 update-source Loopback0

neighbor 2001:DB8:ACAD:4::1 remote-as 12

neighbor 2001:DB8:ACAD:4::1 update-source Loopback0

neighbor 2001:DB8:ACAD:E::2 remote-as 11

neighbor 192.168.0.9 remote-as 12

neighbor 192.168.0.9 update-source Loopback0

neighbor 192.168.0.13 remote-as 12

neighbor 192.168.0.13 update-source Loopback0

neighbor 192.168.0.46 remote-as 11

address-family ipv4

network 192.168.0.44 mask 255.255.255.252

redistribute connected

redistribute eigrp 10

neighbor 192.168.0.9 activate

neighbor 192.168.0.13 activate

neighbor 192.168.0.46 activate

exit-address-family

address-family ipv6

redistribute connected

redistribute eigrp 10

network 2001:DB8:ACAD:E::/64

neighbor 2001:DB8:ACAD:3::1 activate

neighbor 2001:DB8:ACAD:4::1 activate

neighbor 2001:DB8:ACAD:E::2 activate

exit-address-family

ip forward-protocol nd

no ip http server

no ip http secure-server

ipv6 router eigrp 10

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

**R7#show ip route**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2

i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2

ia - IS-IS inter area, \* - candidate default, U - per-user static route

o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

192.168.0.0/24 is variably subnetted, 16 subnets, 2 masks

B 192.168.0.1/32 [200/2] via 192.168.0.33, 00:21:40

B 192.168.0.4/30 [200/0] via 192.168.0.33, 00:21:40

D 192.168.0.8/30

[90/131072] via 192.168.0.41, 00:21:51, GigabitEthernet0/0/1

D 192.168.0.12/30

[90/130816] via 192.168.0.41, 00:21:51, GigabitEthernet0/0/1

C 192.168.0.16/30 is directly connected, Loopback0

L 192.168.0.17/32 is directly connected, Loopback0

B 192.168.0.20/30 [20/0] via 192.168.0.46, 00:22:59

B 192.168.0.25/32 [20/2] via 192.168.0.46, 00:22:59

B 192.168.0.28/30 [200/0] via 192.168.0.33, 00:21:40

D 192.168.0.32/30

[90/3328] via 192.168.0.41, 00:21:51, GigabitEthernet0/0/1

D 192.168.0.36/30

[90/3072] via 192.168.0.41, 00:21:51, GigabitEthernet0/0/1

C 192.168.0.40/30 is directly connected, GigabitEthernet0/0/1

L 192.168.0.42/32 is directly connected, GigabitEthernet0/0/1

C 192.168.0.44/30 is directly connected, GigabitEthernet0/0/0

L 192.168.0.45/32 is directly connected, GigabitEthernet0/0/0

B 192.168.0.48/30 [20/0] via 192.168.0.46, 00:22:59

**R7#show ipv6 route**

IPv6 Routing Table - default - 17 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application

B 2001:DB8:ACAD:1::1/128 [200/1]

via 2001:DB8:ACAD:B::1

B 2001:DB8:ACAD:2::/64 [200/0]

via 2001:DB8:ACAD:B::1

D 2001:DB8:ACAD:3::/64 [90/131072]

via FE80::227:90FF:FEC7:8DB1, GigabitEthernet0/0/1

D 2001:DB8:ACAD:4::/64 [90/130816]

via FE80::227:90FF:FEC7:8DB1, GigabitEthernet0/0/1

C 2001:DB8:ACAD:5::/64 [0/0]

via Loopback0, directly connected

L 2001:DB8:ACAD:5::1/128 [0/0]

via Loopback0, receive

B 2001:DB8:ACAD:6::/64 [20/0]

via FE80::B6A8:B9FF:FE47:92C0, GigabitEthernet0/0/0

B 2001:DB8:ACAD:7::1/128 [20/1]

via FE80::B6A8:B9FF:FE47:92C0, GigabitEthernet0/0/0

B 2001:DB8:ACAD:A::/64 [200/0]

via 2001:DB8:ACAD:B::1

D 2001:DB8:ACAD:B::/64 [90/3328]

via FE80::227:90FF:FEC7:8DB1, GigabitEthernet0/0/1

D 2001:DB8:ACAD:C::/64 [90/3072]

via FE80::227:90FF:FEC7:8DB1, GigabitEthernet0/0/1

C 2001:DB8:ACAD:D::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:DB8:ACAD:D::2/128 [0/0]

via GigabitEthernet0/0/1, receive

C 2001:DB8:ACAD:E::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD:E::1/128 [0/0]

via GigabitEthernet0/0/0, receive

B 2001:DB8:ACAD:F::/64 [20/0]

via FE80::B6A8:B9FF:FE47:92C0, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

**R7#show ip protocols**

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "eigrp 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Default networks flagged in outgoing updates

Default networks accepted from incoming updates

EIGRP-IPv4 Protocol for AS(10)

Metric weight K1=1, K2=0, K3=1, K4=0, K5=0

Soft SIA disabled

NSF-aware route hold timer is 240

EIGRP NSF disabled

NSF signal timer is 20s

NSF converge timer is 120s

Router-ID: 192.168.0.17

Topology : 0 (base)

Active Timer: 3 min

Distance: internal 90 external 170

Maximum path: 4

Maximum hopcount 100

Maximum metric variance 1

Automatic Summarization: disabled

Maximum path: 4

Routing for Networks:

192.168.0.16/30

192.168.0.40/30

192.168.0.44/30

Routing Information Sources:

Gateway Distance Last Update

192.168.0.41 90 00:22:02

Distance: internal 90 external 170

Routing Protocol is "bgp 12"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

IGP synchronization is disabled

Automatic route summarization is disabled

Redistributing: connected, eigrp 10

Neighbor(s):

Address FiltIn FiltOut DistIn DistOut Weight RouteMap

192.168.0.9

192.168.0.13

192.168.0.46

Maximum path: 1

Routing Information Sources:

Gateway Distance Last Update

192.168.0.46 20 00:23:13

192.168.0.9 200 00:21:53

Distance: external 20 internal 200 local 200

**R7#show ipv6 protocols**

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "bgp 12"

IGP synchronization is disabled

Redistribution:

Redistributing protocol connected

Redistributing protocol eigrp 10

Neighbor(s):

Address FiltIn FiltOut Weight RoutemapIn RoutemapOut

2001:DB8:ACAD:3::1

2001:DB8:ACAD:4::1

2001:DB8:ACAD:E::2

IPv6 Routing Protocol is "eigrp 10"

EIGRP-IPv6 Protocol for AS(10)

Metric weight K1=1, K2=0, K3=1, K4=0, K5=0

Soft SIA disabled

NSF-aware route hold timer is 240

EIGRP NSF disabled

NSF signal timer is 20s

NSF converge timer is 120s

Router-ID: 192.168.0.17

Topology : 0 (base)

Active Timer: 3 min

Distance: internal 90 external 170

Maximum path: 16

Maximum hopcount 100

Maximum metric variance 1

Interfaces:

Loopback0

GigabitEthernet0/0/0

GigabitEthernet0/0/1

Redistribution:

None

**R7#show bgp all summary**

For address family: IPv4 Unicast

BGP router identifier 192.168.0.17, local AS number 12

BGP table version is 17, main routing table version 17

13 network entries using 3224 bytes of memory

21 path entries using 2520 bytes of memory

17/10 BGP path/bestpath attribute entries using 4216 bytes of memory

2 BGP AS-PATH entries using 48 bytes of memory

0 BGP route-map cache entries using 0 bytes of memory

0 BGP filter-list cache entries using 0 bytes of memory

BGP using 10008 total bytes of memory

BGP activity 27/1 prefixes, 36/1 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd

192.168.0.9 4 12 38 36 17 0 0 00:22:16 10

192.168.0.13 4 12 30 38 17 0 0 00:22:16 0

192.168.0.46 4 11 32 38 17 0 0 00:24:42 4

For address family: IPv6 Unicast

BGP router identifier 192.168.0.17, local AS number 12

BGP table version is 33, main routing table version 33

13 network entries using 3536 bytes of memory

14 path entries using 2016 bytes of memory

11/10 BGP path/bestpath attribute entries using 2728 bytes of memory

2 BGP AS-PATH entries using 48 bytes of memory

0 BGP route-map cache entries using 0 bytes of memory

0 BGP filter-list cache entries using 0 bytes of memory

BGP using 8328 total bytes of memory

BGP activity 27/1 prefixes, 36/1 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd

2001:DB8:ACAD:3::1

4 12 31 46 33 0 0 00:22:16 3

2001:DB8:ACAD:4::1

4 12 28 44 33 0 0 00:22:16 0

2001:DB8:ACAD:E::2

4 11 36 41 33 0 0 00:24:46 4

**Router 8**

**R8#show running-config**

Current configuration : 2230 bytes

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R8

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

ipv6 unicast-routing

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO214420QQ

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface Loopback0

ip address 192.168.0.21 255.255.255.252

ipv6 address 2001:DB8:ACAD:6::1/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/0

ip address 192.168.0.46 255.255.255.252

negotiation auto

ipv6 address 2001:DB8:ACAD:E::2/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/1

ip address 192.168.0.49 255.255.255.252

negotiation auto

ipv6 address 2001:DB8:ACAD:F::1/64

ipv6 ospf 10 area 0

interface Serial0/1/0

no ip address

shutdown

interface Serial0/1/1

no ip address

shutdown

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

router ospf 10

redistribute bgp 11 subnets

network 192.168.0.20 0.0.0.3 area 0

network 192.168.0.44 0.0.0.3 area 0

network 192.168.0.48 0.0.0.3 area 0

router bgp 11

bgp log-neighbor-changes

no bgp default ipv4-unicast

neighbor 2001:DB8:ACAD:E::1 remote-as 12

neighbor 192.168.0.45 remote-as 12

address-family ipv4

network 192.168.0.44 mask 255.255.255.252

redistribute connected

redistribute ospf 10

neighbor 192.168.0.45 activate

exit-address-family

address-family ipv6

redistribute connected

redistribute ospf 10

network 2001:DB8:ACAD:E::/64

neighbor 2001:DB8:ACAD:E::1 activate

exit-address-family

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

ipv6 router ospf 10

redistribute bgp 11

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

**R8#show ip route**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2

i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2

ia - IS-IS inter area, \* - candidate default, U - per-user static route

o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

192.168.0.0/24 is variably subnetted, 16 subnets, 2 masks

B 192.168.0.1/32 [20/0] via 192.168.0.45, 00:22:51

B 192.168.0.4/30 [20/0] via 192.168.0.45, 00:22:51

B 192.168.0.8/30 [20/131072] via 192.168.0.45, 00:22:51

B 192.168.0.12/30 [20/130816] via 192.168.0.45, 00:22:51

B 192.168.0.16/30 [20/0] via 192.168.0.45, 00:24:28

C 192.168.0.20/30 is directly connected, Loopback0

L 192.168.0.21/32 is directly connected, Loopback0

O 192.168.0.25/32

[110/2] via 192.168.0.50, 00:25:24, GigabitEthernet0/0/1

B 192.168.0.28/30 [20/0] via 192.168.0.45, 00:22:51

B 192.168.0.32/30 [20/3328] via 192.168.0.45, 00:22:51

B 192.168.0.36/30 [20/3072] via 192.168.0.45, 00:22:51

B 192.168.0.40/30 [20/0] via 192.168.0.45, 00:23:22

C 192.168.0.44/30 is directly connected, GigabitEthernet0/0/0

L 192.168.0.46/32 is directly connected, GigabitEthernet0/0/0

C 192.168.0.48/30 is directly connected, GigabitEthernet0/0/1

L 192.168.0.49/32 is directly connected, GigabitEthernet0/0/1

**R8#show ipv6 route**

IPv6 Routing Table - default - 17 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application

B 2001:DB8:ACAD:1::1/128 [20/0]

via FE80::B6A8:B9FF:FE01:AE50, GigabitEthernet0/0/0

B 2001:DB8:ACAD:2::/64 [20/0]

via FE80::B6A8:B9FF:FE01:AE50, GigabitEthernet0/0/0

B 2001:DB8:ACAD:3::/64 [20/131072]

via FE80::B6A8:B9FF:FE01:AE50, GigabitEthernet0/0/0

B 2001:DB8:ACAD:4::/64 [20/130816]

via FE80::B6A8:B9FF:FE01:AE50, GigabitEthernet0/0/0

B 2001:DB8:ACAD:5::/64 [20/0]

via FE80::B6A8:B9FF:FE01:AE50, GigabitEthernet0/0/0

C 2001:DB8:ACAD:6::/64 [0/0]

via Loopback0, directly connected

L 2001:DB8:ACAD:6::1/128 [0/0]

via Loopback0, receive

O 2001:DB8:ACAD:7::1/128 [110/1]

via FE80::521C:B0FF:FE2D:7101, GigabitEthernet0/0/1

B 2001:DB8:ACAD:A::/64 [20/0]

via FE80::B6A8:B9FF:FE01:AE50, GigabitEthernet0/0/0

B 2001:DB8:ACAD:B::/64 [20/3328]

via FE80::B6A8:B9FF:FE01:AE50, GigabitEthernet0/0/0

B 2001:DB8:ACAD:C::/64 [20/3072]

via FE80::B6A8:B9FF:FE01:AE50, GigabitEthernet0/0/0

B 2001:DB8:ACAD:D::/64 [20/0]

via FE80::B6A8:B9FF:FE01:AE50, GigabitEthernet0/0/0

C 2001:DB8:ACAD:E::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD:E::2/128 [0/0]

via GigabitEthernet0/0/0, receive

C 2001:DB8:ACAD:F::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:DB8:ACAD:F::1/128 [0/0]

via GigabitEthernet0/0/1, receive

L FF00::/8 [0/0]

via Null0, receive

**R8#show ip protocols**

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "ospf 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Router ID 192.168.0.21

It is an autonomous system boundary router

Redistributing External Routes from,

bgp 11, includes subnets in redistribution

Number of areas in this router is 1. 1 normal 0 stub 0 nssa

Maximum path: 4

Routing for Networks:

192.168.0.20 0.0.0.3 area 0

192.168.0.44 0.0.0.3 area 0

192.168.0.48 0.0.0.3 area 0

Routing Information Sources:

Gateway Distance Last Update

192.168.0.25 110 00:25:34

Distance: (default is 110)

Routing Protocol is "bgp 11"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

IGP synchronization is disabled

Automatic route summarization is disabled

Redistributing: connected, ospf 10 (internal)

Neighbor(s):

Address FiltIn FiltOut DistIn DistOut Weight RouteMap

192.168.0.45

Maximum path: 1

Routing Information Sources:

Gateway Distance Last Update

192.168.0.45 20 00:23:03

Distance: external 20 internal 200 local 200

**R8#show ipv6 protocols**

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "ospf 10"

Router ID 192.168.0.21

Autonomous system boundary router

Number of areas: 1 normal, 0 stub, 0 nssa

Interfaces (Area 0):

Loopback0

GigabitEthernet0/0/1

GigabitEthernet0/0/0

Redistribution:

Redistributing protocol bgp 11

IPv6 Routing Protocol is "bgp 11"

IGP synchronization is disabled

Redistribution:

Redistributing protocol connected

Redistributing protocol ospf 10 (internal)

Neighbor(s):

Address FiltIn FiltOut Weight RoutemapIn RoutemapOut

2001:DB8:ACAD:E::1

**R8#show bgp all summary**

For address family: IPv4 Unicast

BGP router identifier 192.168.0.21, local AS number 11

BGP table version is 14, main routing table version 14

13 network entries using 3224 bytes of memory

14 path entries using 1680 bytes of memory

10/9 BGP path/bestpath attribute entries using 2480 bytes of memory

2 BGP AS-PATH entries using 64 bytes of memory

0 BGP route-map cache entries using 0 bytes of memory

0 BGP filter-list cache entries using 0 bytes of memory

BGP using 7448 total bytes of memory

BGP activity 27/1 prefixes, 29/1 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd

192.168.0.45 4 12 39 34 14 0 0 00:25:59 10

For address family: IPv6 Unicast

BGP router identifier 192.168.0.21, local AS number 11

BGP table version is 22, main routing table version 22

13 network entries using 3536 bytes of memory

14 path entries using 2016 bytes of memory

10/9 BGP path/bestpath attribute entries using 2480 bytes of memory

2 BGP AS-PATH entries using 64 bytes of memory

0 BGP route-map cache entries using 0 bytes of memory

0 BGP filter-list cache entries using 0 bytes of memory

BGP using 8096 total bytes of memory

BGP activity 27/1 prefixes, 29/1 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd

2001:DB8:ACAD:E::1

4 12 42 37 22 0 0 00:26:03 10

**Router 9**

**R9#show running-config**

Current configuration : 1588 bytes

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R9

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

ipv6 unicast-routing

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO21491LXV

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface Loopback0

ip address 192.168.0.25 255.255.255.252

ipv6 address 2001:DB8:ACAD:7::1/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/0

no ip address

shutdown

negotiation auto

interface GigabitEthernet0/0/1

ip address 192.168.0.50 255.255.255.252

negotiation auto

ipv6 address 2001:DB8:ACAD:F::2/64

ipv6 ospf 10 area 0

interface Serial0/1/0

no ip address

shutdown

interface Serial0/1/1

no ip address

shutdown

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

router ospf 10

network 192.168.0.24 0.0.0.3 area 0

network 192.168.0.48 0.0.0.3 area 0

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

ipv6 router ospf 10

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

**R9#show ip route**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2

i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2

ia - IS-IS inter area, \* - candidate default, U - per-user static route

o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

192.168.0.0/24 is variably subnetted, 15 subnets, 2 masks

O E2 192.168.0.1/32

[110/1] via 192.168.0.49, 00:23:50, GigabitEthernet0/0/1

O E2 192.168.0.4/30

[110/1] via 192.168.0.49, 00:23:50, GigabitEthernet0/0/1

O E2 192.168.0.8/30

[110/1] via 192.168.0.49, 00:23:50, GigabitEthernet0/0/1

O E2 192.168.0.12/30

[110/1] via 192.168.0.49, 00:23:50, GigabitEthernet0/0/1

O E2 192.168.0.16/30

[110/1] via 192.168.0.49, 00:25:26, GigabitEthernet0/0/1

O 192.168.0.21/32

[110/2] via 192.168.0.49, 00:26:23, GigabitEthernet0/0/1

C 192.168.0.24/30 is directly connected, Loopback0

L 192.168.0.25/32 is directly connected, Loopback0

O E2 192.168.0.28/30

[110/1] via 192.168.0.49, 00:23:50, GigabitEthernet0/0/1

O E2 192.168.0.32/30

[110/1] via 192.168.0.49, 00:23:50, GigabitEthernet0/0/1

O E2 192.168.0.36/30

[110/1] via 192.168.0.49, 00:23:50, GigabitEthernet0/0/1

O E2 192.168.0.40/30

[110/1] via 192.168.0.49, 00:24:20, GigabitEthernet0/0/1

O 192.168.0.44/30

[110/2] via 192.168.0.49, 00:26:23, GigabitEthernet0/0/1

C 192.168.0.48/30 is directly connected, GigabitEthernet0/0/1

L 192.168.0.50/32 is directly connected, GigabitEthernet0/0/1

**R9#show ipv6 route**

IPv6 Routing Table - default - 16 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application

OE2 2001:DB8:ACAD:1::1/128 [110/1]

via FE80::B6A8:B9FF:FE47:92C1, GigabitEthernet0/0/1

OE2 2001:DB8:ACAD:2::/64 [110/1]

via FE80::B6A8:B9FF:FE47:92C1, GigabitEthernet0/0/1

OE2 2001:DB8:ACAD:3::/64 [110/1]

via FE80::B6A8:B9FF:FE47:92C1, GigabitEthernet0/0/1

OE2 2001:DB8:ACAD:4::/64 [110/1]

via FE80::B6A8:B9FF:FE47:92C1, GigabitEthernet0/0/1

OE2 2001:DB8:ACAD:5::/64 [110/1]

via FE80::B6A8:B9FF:FE47:92C1, GigabitEthernet0/0/1

O 2001:DB8:ACAD:6::1/128 [110/1]

via FE80::B6A8:B9FF:FE47:92C1, GigabitEthernet0/0/1

C 2001:DB8:ACAD:7::/64 [0/0]

via Loopback0, directly connected

L 2001:DB8:ACAD:7::1/128 [0/0]

via Loopback0, receive

OE2 2001:DB8:ACAD:A::/64 [110/1]

via FE80::B6A8:B9FF:FE47:92C1, GigabitEthernet0/0/1

OE2 2001:DB8:ACAD:B::/64 [110/1]

via FE80::B6A8:B9FF:FE47:92C1, GigabitEthernet0/0/1

OE2 2001:DB8:ACAD:C::/64 [110/1]

via FE80::B6A8:B9FF:FE47:92C1, GigabitEthernet0/0/1

OE2 2001:DB8:ACAD:D::/64 [110/1]

via FE80::B6A8:B9FF:FE47:92C1, GigabitEthernet0/0/1

O 2001:DB8:ACAD:E::/64 [110/2]

via FE80::B6A8:B9FF:FE47:92C1, GigabitEthernet0/0/1

C 2001:DB8:ACAD:F::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:DB8:ACAD:F::2/128 [0/0]

via GigabitEthernet0/0/1, receive

L FF00::/8 [0/0]

via Null0, receive

**R9#show ip protocols**

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "ospf 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Router ID 192.168.0.25

Number of areas in this router is 1. 1 normal 0 stub 0 nssa

Maximum path: 4

Routing for Networks:

192.168.0.24 0.0.0.3 area 0

192.168.0.48 0.0.0.3 area 0

Routing Information Sources:

Gateway Distance Last Update

192.168.0.21 110 00:24:00

Distance: (default is 110)

**R9#show ipv6 protocols**

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "ospf 10"

Router ID 192.168.0.25

Number of areas: 1 normal, 0 stub, 0 nssa

Interfaces (Area 0):

Loopback0

GigabitEthernet0/0/1

Redistribution:

None

**Connectivity Tests**

**IPv4 Pings**

R3#ping 192.168.0.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.5

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.5, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.9

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.9, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.13

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.13, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.17

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.17, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.21

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.21, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.25

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.25, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms

R3#ping 192.168.0.29

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.29, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.30

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.30, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.33

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.33, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.34

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.34, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.37

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.37, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.38

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.38, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.41

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.41, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.42

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.42, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.45

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.45, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.46

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.46, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.49

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.49, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.50

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.0.50, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

**IPv6 Pings**

R9#ping 2001:db8:acad:1::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:1::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:2::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:2::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:3::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:3::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:4::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:4::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:5::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:5::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:6::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:6::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:7::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:7::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:a::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:A::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:a::2

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:A::2, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:b::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:B::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:b::2

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:B::2, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:c::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:C::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:c::2

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:C::2, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:d::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:D::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:d::2

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:D::2, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:e::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:E::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:e::2

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:E::2, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:f::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:F::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R9#ping 2001:db8:acad:f::2

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:F::2, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

**Problems**

Router 4’s loopback address was unreachable from Router 3 using IPv6. Running **show ipv6 route** on other Router 3 showed that no such route existed for Router 4’s loopback address when an OSPF route should have existed. **Show ipv6 protocols** was run on Router 4 to verify that it had advertised its loopback address through OSPF. Router 4 was missing this. **Ipv6 ospf 10 area 0** was run on Router 4’s loopback interface configuration mode and Router 3’s connectivity with Router 4 was restored.

The network link between Router 3 and Router 4 was unreachable for both IPv4 and IPv6. After running **show ip route** and **show ip protocols**, it was found that there was a missing **redistribute connected** command through Router 4’s external BGP configuration. This was then applied to Router 4’s BGP in both IPv4 and IPv6 and the network was now reachable. Although the BGP was distributing the OSPF connections, the network link between Router 3 and Router 4 was seen by Router 4 as a directly connected link. As a result, Router 4’s BGP redistribution of OSPF would not include this directly connected link.

Router 3 was unable to ping external networks using IPv6. **Show ipv6 route** was used on Router 3 to determine that it was missing external OSPF routes. Since Router 3 is not responsible for external OSPF routes, attention turned to Router 4. **Show ipv6 protocols** was run on Router 4 to find that it was missing a redistribute BGP command in OSPF configuration. After running the **redistribute bgp 10** command in OSPFv3 configuration mode, Router 3 could ping outside of its internal network.

Routers on the first site and third site were unable to ping each other with both IPv4 and IPv6. After running **show ip route** on Routers on both sites, their routing tables were verified to be correct. Because the routing tables were correct on both ends, it was suspected that the problem lied within the second site. A **traceroute** was run from end to end in order to find out where the packet was dropped. The packet was found to have been dropped at Router 6, suggesting that Router 6 had no routes to either end. A **show ip route** was run on Router 6 and it had no BGP routes to either the first site or the second site. In order to give Router 6 these routes, it was then configured as an iBGP neighbor alongside Routers 5 and 7. This way, Routers 5 and 7 would share their external BGP learned routes through iBGP to router 6. After configuring this neighbor relationship for both IPv4 and IPv6, full connectivity across all sites was restored.

**Conclusion**

This lab demonstrated the usage of BGP for internal route distribution. Though less popular than EBGP, which is used to connect external organizations together, the popularity of EBGP justifies the usage of IBGP internally to distribute routes. IBGP preserves and packages EBGP control information in their distribution, which adds to its flexibility as a protocol. IBGP does not replace internal routing protocols as it requires it to run concurrently, but it is useful when connecting two external organizations through a central organization to bridge between multiple EBGP connections.